

## VARIATIONS IN THE CHIEF ASH CONSTITUENTS OF APPLES AFFECTED WITH BLOTCHY CORK

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In February, 1932, two samples of apples of the Fallawater variety, one badly affected with blotchy cork (locally known as "bitter-pit"), the other showing no symptoms of this disorder, were sent to this laboratory for analysis. These samples had been selected from the grading-table in a fruit warehouse and their tree origins were therefore unknown. They were known, however, to have been grown in the same orchard. The samples were analyzed for inorganic constituents and but one apparently significant difference was found, namely, in calcium content. Thus the affected fruit contained 0.052 gm. CaO per 1000 gm. fresh weight; the unaffected, 0.071 gm.

A favorable opportunity for checking this result on fruit collected directly from the trees presented itself in the autumn of 1934. At this time five samples of apples of the variety Stark were gathered as follows:

A. Fruit from a tree about 40 years old which had recently been severely headed back and was making the usual vigorous vegetative growth following this operation. It was bearing a full crop of fruit, which was estimated to be 5 to 10 per cent. affected with blotchy cork. The section of the orchard in which this tree was growing was inter-planted with corn for ensilage in 1934. All the apples collected showed many typical lesions and this sample was classified as showing very severe symptoms.

B. Fruit collected from a normally-pruned tree about 50 years of age located in an orchard about one-half mile from the preceding. This orchard was cultivated and cropped to oats and corn in 1934. The crop borne by the selected tree was heavy and it was estimated that about 3 per cent. of the fruit showed easily recognizable corky lesions at the time of collection. All the apples in this sample also showed numerous corky areas. The sample was classified as severely affected.

C. Fruit collected from a tree about 30 years old located in an orchard about midway between A and B. The sod mulch system of culture was followed in this orchard, the crop in 1934 was very light, the trees were not over-vegetative, and only a few fruits at the tops of certain trees showed blotchy cork symptoms. All the apples making up this sample exhibited corky lesions, however, and it was classed as slightly to moderately affected.

D. A composite sample made up as follows: (a) ten apples from the tree adjacent to the one from which sample A was taken, (b) ten apples from the same tree from which sample B was gathered, and (c) five apples each from two trees adjacent to the one from which sample C was taken.

None of the fruits of this sample C showed any visible corky lesions, although in the cases (a) and (b) the trees were certainly "cork-susceptible" in 1934, and possibly also in case (c).

E. Fruit from trees grown at the Dominion Experimental Farm at Kentville, Nova Scotia. These trees have been under continuous observation since they began to bear and have never been found to produce fruit affected with any of the so-called physiological disorders of the cork type. A system of clean cultivation followed by a cover-crop of vetch is the practice in this orchard and the trees are 25 years old.

Samples A-D inclusive were gathered September 22, 1934, at Windsor Forks, Nova Scotia. Sample E was collected September 26. The soils in the various orchards are of similar type, ranging from a sandy loam at Kentville to a gravelly soil in the case of orchard C at Windsor Forks.

After collection, the samples, which consisted of 30 apples each, were at once taken to the laboratory where they were pared and sliced for drying. The parings and the flesh of the fruit, the latter minus the seeds and stems, were dried, ashed, and analyzed separately. The methods of analysis followed were those of the A. O. A. C. except that the magnesium, after separation from iron, calcium, etc., was determined by the hydroxy-quinoline method, and the potassium by the butyl alcohol-perchlorate method. The analytical results are reported in table I.

TABLE I  
ASH ANALYSES OF STARK APPLES, A, B, C, AFFECTED WITH BLOTCHY CORK,  
D AND E UNAFFECTED

SAMPLE	ASH IN FRESH WEIGHT	PERCENTAGE IN THE ASH				AVERAGE FRESH WEIGHT PER APPLE
		P <sub>2</sub> O <sub>5</sub>	CaO	MgO	K <sub>2</sub> O	
	%	%	%	%	%	gm.
ANALYTICAL RESULTS ON PARINGS						
A .....	0.528	10.2	1.27	4.32	56.1	124.1
B .....	0.550	10.5	1.56	4.53	55.4	119.7
C .....	0.627	12.6	1.67	4.67	55.8	132.7
D .....	0.478	11.1	2.41	4.54	55.5	124.9
E .....	0.476	10.2	3.57	4.61	53.2	120.2
ANALYTICAL RESULTS ON FLESH						
A .....	0.243	9.5	1.67	3.33	56.1	.....
B .....	0.256	10.8	1.80	3.58	55.1	.....
C .....	0.264	11.1	1.76	3.43	56.2	.....
D .....	0.238	10.1	2.32	3.54	56.2	.....
E .....	0.235	11.6	2.99	3.63	54.7	.....

The results obtained in table I are seen to confirm those found in 1932, the most striking deviation in inorganic composition of affected as compared with unaffected fruit (sample D) and with fruit from non-susceptible trees (sample E), and probably the only significant one, being found in the calcium content. It is true that sample C shows a somewhat high ash content and content of phosphorus in the ash. This, however, is probably to be attributed to the fact that these trees were bearing a light crop in 1934 (2), rather than to any specific effect related to the incidence of blotchy cork.

In the case of the calcium content, the percentage values of table I show a striking diminution of this element as the severity of attack of the disorder increases. From the physiological standpoint a more correct picture of the situation with respect to this element is doubtless given by calculating the amount present per unit of fresh weight. When this is done and the results are expressed as percentages of the quantity of calcium present per unit of fresh weight in sample E (*i.e.*, fruit from non-susceptible trees), the results shown in table II are obtained.

TABLE II  
RELATIVE AMOUNTS OF CALCIUM PER UNIT OF FRESH WEIGHT

SAMPLE	PARINGS	FLESH
A .....	40	59
B .....	51	67
C .....	62	67
D .....	68	79
E .....	100	100

The cause of this apparent calcium deficit in fruit affected with blotchy cork is uncertain. It has been shown (5), however, that of the total amount of this element in the non-woody tissues of the apple tree (the leaves and fruit), some 90 per cent. is found in the leaves. It is also well established that blotchy cork commonly occurs on what may be classed as over-vegetative trees. Further, unpublished data obtained in this laboratory (3) indicate that calcium is being absorbed most rapidly by the growing fruit coincidently with the most rapid production of new shoots and leaves by the tree. It is therefore suggested that a low calcium content in apples affected with this disorder may arise as a result of competition between leafy shoot and fruit tissues for this element during these early stages of growth. Possibly this apparent calcium deficit may play a part in the origin of the lesions typical of this disorder. In this connection it is also interesting to note that boron is reported (4) to be associated in some way with the calcium nutrition of plants, and that ATKINSON has recently stated (1) that he

has obtained amelioration of cork symptoms on fruit following treatment of apple trees with boric acid.

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